Claims

1. A miniature capacitor, comprising:

a first electrode;

a dielectric structure deposited over the first electrode, the dielectric structure having an overall capacitance density of greater than 25 nF/mm^2, including:

a current leakage inhibiting layer having a thickness of between 15Å and 45Å, and

a substantial amount of Nb_2O_5 in combination with the current leakage inhibiting layer; and

a second electrode deposited over the dielectric structure.

2. A miniature capacitor in accordance with claim 1 wherein the dielectric structure is a multilayer structure and the current leakage inhibiting layer includes a layer of Al_2O_3 at least 22Å thick.

3. A miniature capacitor in accordance with claim 1 wherein the dielectric structure is a multilayer structure and the current leakage inhibiting layer includes a layer of HfO_2 at least 22Å thick.

4. A miniature capacitor in accordance with claim 1 wherein the dielectric structure is a multilayer structure and the current leakage inhibiting layer includes a layer of ZrO_2 at least 22Å thick.

5. A miniature capacitor in accordance with claim 1 wherein the dielectric structure is a multilayer structure and the current leakage inhibiting layer includes a layer of SiO_2 at least 22Å thick.

6. A miniature capacitor in accordance with claim 1 wherein the overall capacitance density is greater than 30 nF/mm^2 and the dielectric structure further has a leakage current density of less than $1.0x10^{-7}$ $amps/cm^2$.

7. A miniature capacitor in accordance with claim 1 wherein the overall capacitance density of greater than 50 nF/mm^2 and a leakage current density of less than $1.0x10^{-5}$ $amps/cm^2$.

8. A miniature capacitor in accordance with claim 1 wherein at least one of the first and second electrodes includes NbN.

9. A miniature capacitor in accordance with claim 1 wherein at least one of the first and second electrodes includes a transition metal nitride material selected from the group consisting essentially of WN, WSiN, TaN, and TiSiN.

10. A miniature capacitor in accordance with claim 1 wherein at least one of the first and second electrodes includes a noble metal or noble metal alloy material selected from the group consisting essentially of Pt, Pt alloy, Ir, Ir alloy, Pd, Pd alloy, RuO_x, and IrO_x.

11. A miniature capacitor in accordance with claim 1 wherein the dielectric structure is formed by ALD.

11. A miniature capacitor in accordance with claim 1 wherein at least one of the first and second electrodes is formed by ALD.

12. A miniature capacitor in accordance with claim 1 wherein the dielectric structure and at least one of the first and second electrodes is formed in an ALD reaction chamber in a single processing cycle.

13. A miniature capacitor in accordance with claim 1 wherein the dielectric structure is a multilayer structure and the current leakage inhibiting layer includes at least two separate layers of a current leakage inhibiting material and at least one layer of Nb_2O_5 material interposed between the layers of the current leakage inhibiting material.

14. A DRAM device including a miniature capacitor in accordance with claim 1.

15. A method of forming a dielectric structure on a substrate, comprising:

depositing a current leakage inhibiting material over the substrate until the current leakage inhibiting material is between 15Å and 45Å thick; and

depositing a substantial amount of Nb_2O_5 over the substrate in combination with the current leakage inhibiting material, wherein the resulting dielectric structure has an overall thickness of at least approximately 49Å and an overall capacitance density of greater than 25 nF/mm^2.

16. A method in accordance with claim 15 wherein:

the depositing of the current leakage inhibiting material includes depositing a layer of Al_2O_3; and

the depositing of the Nb_2O_5 includes depositing a layer including a substantial amount of Nb_2O_5 overlying the layer of Al_2O_3.

17. A method in accordance with claim 15 further comprising forming a protective cap layer over the current leakage inhibiting material and the Nb_2O_5 via ALD.

18. A method in accordance with claim 15 further comprising forming an electrode over the substrate before depositing the current leakage inhibiting material and the Nb_2O_5.

19. A method in accordance with claim 18 wherein the Nb_2O_5 is deposited against the electrode and the electrode includes NbN.

20. A method in accordance with claim 18 wherein Nb_2O_5 is deposited against the electrode and the electrode includes a transition metal nitride material selected from the group consisting of WN, WSiN, TaN, and TiSiN .

21. A method in accordance with claim 18 wherein Nb_2O_5 is deposited against the electrode and the electrode includes a noble metal or noble metal alloy material selected from the group consisting essentially of Pt, Pt alloy, Ir, Ir alloy, Pd, Pd alloy, RuO_x, and IrO_x.

22. A method in accordance with claim 15 wherein the depositing of the current leakage inhibiting material and the Nb_2O_5 includes forming a multi-layer structure having two or more layers of current leakage inhibiting material and one or more layers of Nb_2O_5.

23. A method in accordance with claim 15 wherein ALD is used to deposit the current leakage inhibiting material and the Nb_2O_5.

24. A miniature capacitor including a dielectric structure formed in accordance with the method of claim 15.

25. A DRAM device including miniature capacitors having dielectric structures formed in accordance with the method of claim 15.

26. A niobium containing dielectric structure formed by ALD and characterized by a capacitance density of greater than 30 nF/mm^2 and a leakage current density of less than $1.0x10^{-7}$ $amps/cm^2$.

27. A miniature capacitor including a niobium containing dielectric structure in accordance with claim 26.

28. A DRAM device including a miniature capacitor in accordance with claim 27.

29. A niobium containing dielectric structure formed by ALD and characterized by a capacitance density of greater than 50 nF/mm^2 and a leakage current density of less than $1.0x10^{-5}$ $amps/cm^2$.

30. A miniature capacitor including a niobium containing dielectric structure in accordance with claim 29.

31. A DRAM device including a miniature capacitor in accordance with claim 30.